AMMUNITION STORAGE ANALYSIS MODEL

In 1965 Edwin A. Keeble Associates, Inc. was the first group to start looking at ways to compute magazine requirements for ammunition. Before that time, a number of “rule of thumb” methods for computations had been used. Using the findings of the Keeble Associates and the Navy rules for storing ammunition in OP 5 , I have developed an ammunition storage model for determining magazine requirements. The Ammunition Storage Analysis Model is a series of computer programs that simulate a mixed-integer linear program. The Ammunition Storage Analysis Model attempts to determine the best locations to safely store a given quantity of ammunition in a given set of magazines. Best being defined as storing with the least amount of "wasted space". Wasted space is defined as the difference between a magazine's physical capacity (volume) and the volume of the material stored in the magazine.

The model uses two basic types of magazines. The igloo, with 25 by 80 foot being the standard, (Figures 1 & 2) and the box, with the 50 by 100 SP&P being the standard.(Figures 3 & 4) The model does takes into consideration other non-standard sizes. The model has to take into consideration, as well as physical size and shape of the magazines, the physical size of the ammunition, and the safety characteristics of the ammunition. That is, ammunition from one compatibility group can not be stored with ammunition from another compatibility group, and the total N.E.W. for any quantity distance factor cannot exceed the allowable N.E.W. for each magazine for that quantity distance factor. Safety factors of OP 5 are also considered. That is, you can not store ammunition within 6 inches of the back wall, side walls or ceiling and not within 2 feet 6 inches of the front wall. Eighteen inches aisles are left between every other stack of ammunition to allow for inventory and inspections. To minimize restows within the

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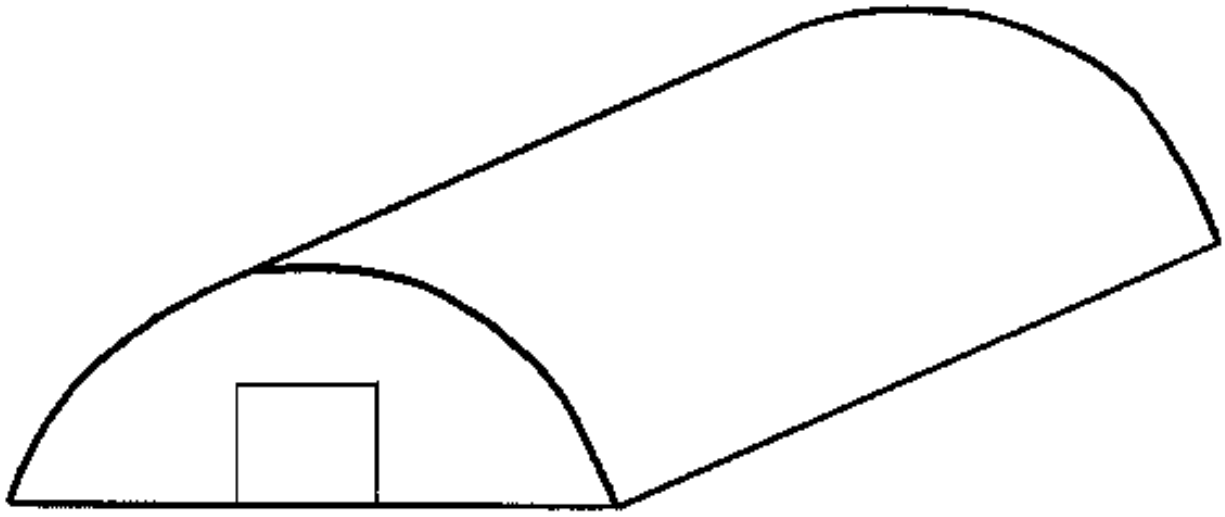
magazines the model allows for any pallet of ammunition to be reached without moving more than three other stacks of ammunition.



IGLOO MAGAZINE

Figure 1

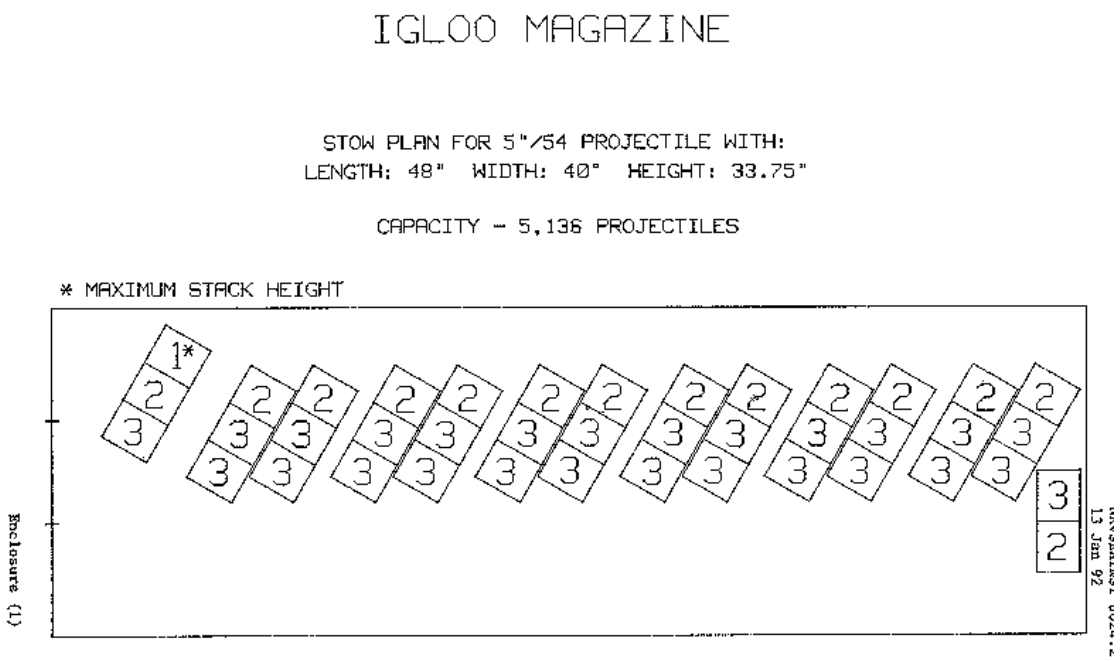


Figure 2

SP&P
AMRAAM

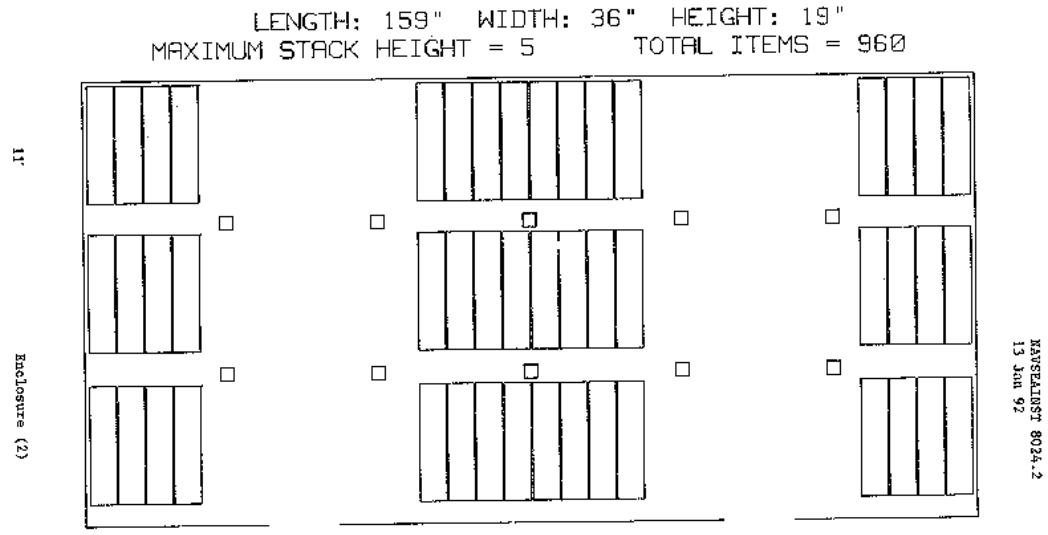


Figure 3

SP&P TYPE I-A MAGAZINE
(50' x 100')

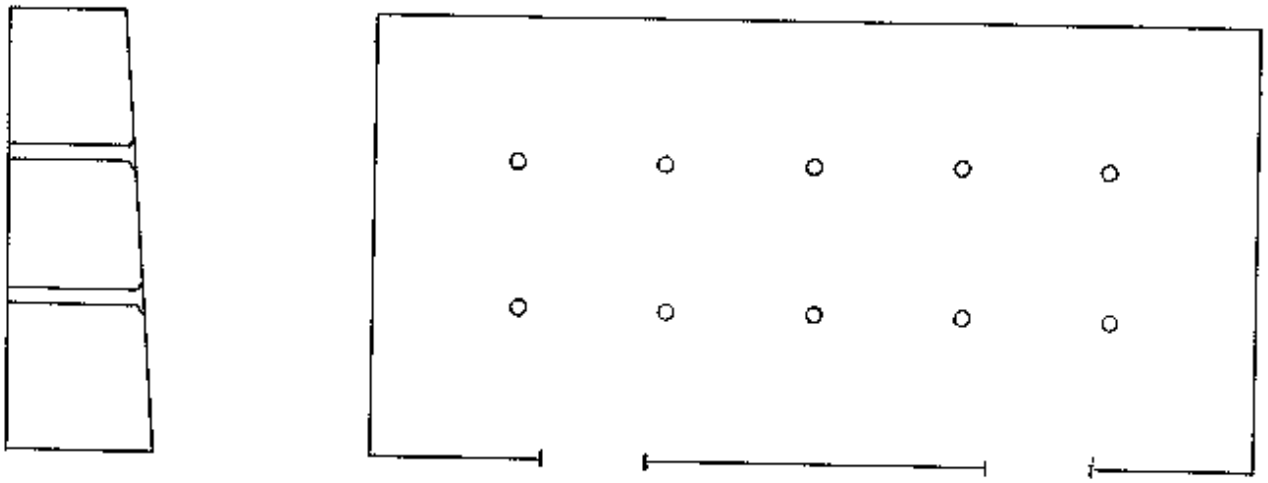


Figure 4

The results of the model consist of three parts. Part one is simply a yes or no answer. Can the ammunition be stored safely in the given magazines? If not, part one also tells how many more magazines would need to be constructed to safely store the remainder of the ammunition. Part 2 consists of a chart telling how much of the available space it takes to store the ammunition and actually how much space is wasted. This chart is in tons, square feet, as well as cubic feet. Part 3 is a listing of each magazine and which pieces of ammunition it would be best to store in each magazine.

Part One:
There is enough space to store the required ammunition.

Part Two:

SECTION	TONS STORED	TON CAPACITY	TONS REQUIRED	TON LOSS DUE TO SAFETY CONSTRAINTS	STORED SQUARE FT	AVAILABLE EMPTY SQUARE FT	SQUARE FEET REQUIRED	SQUARE FEET LOSS DUE TO SAFETY CONSTRAINTS	STORED CUBE	AVAILABLE EMPTY CUBE	CUBE REQUIRED	CUBE LOSS DUE TO SAFETY CONSTRAINTS
COAST GUARD	254	#########	254	376	6,094	##########	3,875	1,922	104,782	##########	43,394	56,612
AIR FORCE	0	#########	0	0	0	##########	0	0	0	##########	0	0
ARMY	1,060	#########	1,060	1,569	18,763	##########	11,931	5,919	326,875	##########	135,370	176,605
NAVY	2,084	#########	2,084	3,084	29,144	##########	18,532	9,194	501,318	##########	207,613	270,854
USMC V(W)	1,058	#########	1,058	1,566	33,248	##########	21,142	10,489	643,634	##########	266,551	347,746
SPECWAR	239	#########	239	354	5,558	##########	3,534	1,753	95,196	##########	39,424	51,433
OTHER	0	#########	0	0	0	##########	0	0	0	##########	0	0
TOTAL	4,695	12,842	4,695	6,950	92,806	339,033	59,014	29,277	1,671,805	5,739,806	692,352	903,251

SECTION	TONS STORED	TON CAPACITY	TONS REQUIRED	TON LOSS DUE TO SAFETY CONSTRAINTS	STORED SQUARE FT	AVAILABLE EMPTY SQUARE FT	SQUARE FEET REQUIRED	SQUARE FEET LOSS DUE TO SAFETY CONSTRAINTS	STORED CUBE	AVAILABLE EMPTY CUBE	CUBE REQUIRED	CUBE LOSS DUE TO SAFETY CONSTRAINTS
EXPLOSIVE	4,583	10,518	4,583	6,950	91,009	303,534	61,732	29,277	1,644,974	4,938,757	741,723	903,251
INERT	112	2,325	112	0	1,797	35,499	1,797	0	26,831	801,049	26,831	0

Part Three:

MAGAZINE	NALC	SCG	HAZARD	SRC	N.E.W.	QUANTITY	TONS	NOMENCLATURE	
ATX 255	G881	F	1.1	2	0.11	20611	11.810	GRENADE,HAND	FRAGMENTATI
(TOTAL)			1.1	2	2267.21		11.810		
ATX 259	M913	D	1.1	2	1750.00	70	105.000	CHARGE,DEMOLITION	LINEAR, HE, C
(TOTAL)			1.1	2	122500.00		105.000		
ATX 260	K250	D	1.1	2	21.00	63	1.196	MINE,ANTITANK	HE,NON-META
ATX 260	M023	D	1.1	2	1.25	197	0.222	CHARGE,DEMOLITION	BLOCK TYPE,
ATX 260	M032	D	1.1	2	1.00	16452	12.446	CHARGE,DEMOLITION	BLOCK,1-LB.
ATX 260	M039	D	1.1	2	43.00	197	5.508	CHARGE,DEMOLITION	BLOCK,40 LB
ATX 260	M420	D	1.1	2	15.00	209	2.470	CHARGE,DEMOLITION	SHAPED,15 L
ATX 260	M421	D	1.1	2	40.00	197	6.969	CHARGE,DEMOLITION	SHAPED,40 L
ATX 260	M591	D	1.1	2	0.63	924	0.481	DYNAMITE,MILITARY	MI,PA-PD-52
			1.1	2	38084.75		29.292		
ATX 261	M913	D	1.1	2	1750.00	16	24.000	CHARGE,DEMOLITION	LINEAR,HE,C
ATX 261	M980	D	1.1	2	18.20	8	0.104	CHARGE DEMOLITION	EXPLOSIVE S
ATX 261	M982	D	1.1	2	20.00	8	0.080	CHARGE DEMOLITION	EXPLOSIVE S
ATX 261	ML25	D	1.1	2	1750.00	92	115.000	CHARGE,DEMOLITION,LINEAR,HE,COMP C4	M59,W/FUZE
			1.1	2	189305.60		139.184		
3 PCZ 152	C995	E	1.1	1	1.77	1199	15.857	LAUNCHER AND CARTRIDGE 84 MILLIMETER	HE,ANTI-ARM
3 PCZ 152	HX05	E	1.1	2	1.86	4582	29.783	ROCKET,ASSAULT,(SHAW),ENCASED,83MM,	DUAL MODE,H.
3 PCZ 152	HX06	E	1.1	2	2.76	804	8.844	ROCKET,ASSAULT,ENCASED,83MM,HEAA,(SM	AW) MK6-0,
3 PCZ 152	K092	E	(08)1.2	2	1.15	279	1.635	MINE,APERS	M16,AND FUZ
3 PCZ 152	PM80	E	(04)1.2	1	8.52	406	13.601	GUIDED MISSILE AND LAUNCHER,	HEAT (DRAGO
			1.1	1	16669.71		69.720		
3 PCZ 153	B646	H	(12)1.2	3	0.10	7274	15.774	CARTRIDGE,60 MILLIMETER	SMOKE,WP XM
3 PCZ 153	D528	H	(12)1.2	U	15.60	541	27.894	PROJECTILE,155 MILLIMETER	SMOKE,WP,M8
3 PCZ 153	D550	H	(12)1.2	U	15.60	1543	75.916	PROJECTILE,155 MILLIMETER	SMOKE,WP,M1
			(12)1.2	3	33216.92		119.583		
3 PCZ 154	K143	D	1.1	2	1.57	251	1.203	MINE,APERS	M18/T48,W/A
3 PCZ 154	K180	D	1.1	2	22.80	183	4.770	MINE,ANTITANK	HE,HEAVY,MI
3 PCZ 154	K181	D	1.1	2	10.80	126	1.166	MINE,ANTITANK	HE,HEAVY,M2
3 PCZ 154	M456	D	1.1	3	0.01	476814	30.993	CORD,DETONATING	REINFORCED,
3 PCZ 154	M757	D	1.1	2	10.04	7162	109.435	CHARGE ASSEMBLY,DEMOLITION	M183,CONSIS
3 PCZ 154	M981	D	1.1	2	18.20	12	0.156	CHARGE DEMOLITION	EXPLOSIVE S
3 PCZ 154	MM41	D	1.1	2	0.03	12	0.021	CHARGE DEMOLITION	SHAPED,FLEX
3 PCZ 154	MM42	D	1.1	2	0.03	12	0.021	CHARGE DEMOLITION	SHAPED,FLEX
3 PCZ 154	MM43	D	1.1	2	0.05	12	0.022	CHARGE DEMOLITION	SHAPED,FLEX

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